Fact Sheet • October 2000

National Spent Nuclear Fuel Program

Remote Robotic Welding/ Nondestructive Examination

Mission
Develop a remote welding and examination process that can deposit and inspect the final closure seal weld

Benefits
- High integrity welds through remote welding and nondestructive examination
- Concurrent welding and volumetric weld inspection on a pass-by-pass basis
- Permanent and retrievable weld and nondestructive examination records to meet ASME Code
- "As Low As Reasonably Achievable" radiation exposure
- Minimization of weld heat input during closure and repair welding

Project Status
- Optimizing welding parameters
- Validating robotic welding and examination techniques

Purpose
Develop a remote welding and nondestructive examination technology to 1) perform and inspect closure welds on the standardized U.S. Department of Energy (DOE) spent nuclear fuel canister, 2) meet American Society of Mechanical Engineers (ASME) fabrication code requirements, 3) minimize weld heat input and metallurgical structure interruption, and 4) minimize radiation exposure to operating personnel.

Gas-tungsten arc weld option for closure weld.

Project Description
Closure welding is the final step in sealing the standardized DOE spent nuclear fuel canisters and cans. Because the canister does not incorporate shielding, a high radiation field could exist and pose an unacceptable risk to workers. Therefore, the packaging process must include cell use to perform final closure welds and nondestructive examination. This project defines the remote welding and nondestructive examination process parameters, equipment characteristics, and parameter ranges. The weld parameters must minimize aging and ensure the long-term thermal/microstructural stability of canister and can materials. Design and development of the remote equipment for real-time weld quality determinations must minimize weld repairs after final ASME Code examination and minimize the heat input during weld repair. This project includes 1) developing concurrent pass-by-pass welding and nondestructive examinations and repair techniques, 2) verifying weld surfaces and volumes to the ASME code, and 3) identifying and developing a permanent records technique.

Benefits
The remote welding and nondestructive examination techniques will ensure weld integrity, minimize weld repair, and provide high integrity welds. Volumetric weld inspection on a pass-by-pass basis will minimize the amount of metal removed in making repairs. A digitized software format will retain permanent and retrievable weld and nondestructive examination data.

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Remote welding and nondestructive examination will also protect the worker and maintain “As Low as Reasonably Achievable” radiation control goals. This closure welding process will also maintain the microstructure stability of the canister material because it minimizes heat input.

Gas welding equipment and close-up of welding head.

Unique Capabilities

- Remote weld and nondestructive examination equipment performs well in high radiation fields where welding equipment tends to fail
- Optimized welding parameters for thermal/microstructural stabilization minimizes microstructural change for good corrosion resistance
- Inprocess weld inspection on a volumetric pass-by-pass basis ensures immediate weld repairs and minimizes heat input
- Remote post-weld volumetric, surface, and visual weld inspection performed to ASME Code verifies the weld integrity without operator involvement.

Project Status

Remote welding and nondestructive examination tasks began in October 1999. Researchers are optimizing weld parameters and developing remote pass-by-pass ultrasonic, eddy current, and visual inspection of weld surfaces and volumes. Experimental tests are underway to validate the techniques. These techniques accommodate narrower groove joint designs and use catalyst slurries. Welding baseline parameter determinations are complete. Design, fabrication, and testing of visual topography, surface eddy current, and volumetric ultrasonic equipment began in January 2000.

October 1999
Program was developed

January 2000
Design, fabrication, and testing of visual topography, surface eddy current, and volumetric ultrasonic equipment began

September 2001
Weld process baseline

May 2002
Ultrasonic Testing sensor design

June 2002
Scanning laser camera design

February 2003
Surface examination system

September 2003
System integration

January 2004
Prototype demonstrations

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